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AUTHOR Webb, L. Dean
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ABSTRACT

This booklet is part of a series that was designed to serve as a resource for high school leaders. It focuses on the integration of technology in the high school and contains practical strategies, procedures, and ideas to enable school leaders to plan and implement programs that will help students. It highlights the findings in the National Association of Secondary School Principals' publication "Breaking Ranks: Changing an American Institution." The text expands on the idea that high schools can enrich and expand virtually every activity, operation, and course by using computers and other technologies. It focuses on technology education and the need to distinguish between instruction about technology and the use of technology to teach skills, ideas, or concepts that may have no relationship to technology. It also describes technology performance standards and competencies for students, providing a listing of competencies that were adopted by one school district. Some challenges to technology integration in the high school, such as the lack of resources, the time needed to train teachers, and the need for technical support are also covered. The principal's role in technology and his or her oversight of funding, technical support, the technology plan, and assessment are outlined. (Contains 12 references.) (RJM)

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NATIONAL ALLIANCE OF HIGH SCHOOLS
BREAKING RANKS: MAKING IT HAPPEN

INTEGRATING TECHNOLOGY IN THE HIGH SCHOOL

L. Dean Webb
Professor
Educational Leadership
and Policy Studies
Arizona State University, Tempe

With Materials Provided by
Farmington (Mich.) Public Schools
Plano (Tex.) Independent School District
Rockford (Mich.) Public School System

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NATIONAL ASSOCIATION OF SECONDARY SCHOOL PRINCIPALS
1904 ASSOCIATION DRIVE, RESTON, VIRGINIA 20191-1537
(703) 860-0200 • (800) 253-7746 • FAX (703) 476-5432

Introduction to the Series

The "Making It Happen" series was developed by the National Alliance of High Schools (NAHS) Advisory Council to serve as a resource for high school leaders. The contents are recommended practical strategies, procedures, and ideas to enable school leaders to successfully plan and implement programs that will provide opportunities for students to be adequately prepared for the 21st century.

Topics have been selected for this series by the NAHS Advisory Council, using a priority grid process, from among the range of recommendations, themes, and programs discussed in *Breaking Ranks: Changing an American Institution.*

The "how-to" strategies are designed to provide clear and concise procedures for successful implementation and outcomes in your school improvement plan. The strategies are based on research and also "best practices" of current schools.

The Council welcomes input regarding additional programs that support the recommendations and themes cited in *Breaking Ranks.*

L. Dean Webb is the editor for the "Making It Happen" series.

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National Association of Secondary School Principals

Executive Director: Gerald N. Tirozzi

Associate Executive Director, Director of High School Services
and the National Alliance of High Schools: John A. Lammel

Director of Communications: Robert Mahaffey

Associate Director, National School Alliances: Patricia George

Editor: Jan M. Umphrey

National Association of Secondary School Principals
1904 Association Drive
Reston, VA 20191–1537
(703) 860-0200
(800) 253-7746
nassp@nassp.org

Integrating Technology in the High School

Within the past decade, technology has brought a virtual transformation to almost every industry and institution in the United States. Within education, the impact has been less consistent. While some school districts have indeed been transformed by technology, many others seem relatively untouched, despite the fact that parents increasingly view technology as essential to their child's education, the business community considers it a mandatory part of a student's preparation for the workplace, and educators and policymakers believe it is a critical ingredient in school reform (Trotter, 1997). Technology is seen as supporting reform in the following ways:

- In the classroom, technologies that support exploration, such as the Internet and desktop presentation tools, can create a synergy with "constructivist" teaching methods.
- Providing teachers with high-tech training, personal computers, telephones, and Internet connections is a step toward increasing their professionalism. Technology also can reduce teachers' isolation and lead to professional communities of educators in cyberspace.
- Technology can help measure academic achievement as assessments of student performance grow more complex.
- The movement to restructure schools—to decentralize decision making and share it with teachers or school-level councils—can be aided by networks that collect and distribute information. Databases of student information can help teachers target resources and appropriate teaching methods toward individual students.
- Computer tools that streamline administrative tasks can improve school accountability and free up more resources for the classroom (Trotter, 1997, p. 8).

The National Association of Secondary School Principals, in *Breaking Ranks: Changing an American Institution* (NASSP, 1996), recognized the important role of technology in educational reform and made a number of recommendations related to its integration and utilization. These are presented in Table 1.

Table 1

Technology Recommendations from *Breaking Ranks*

- Teachers will utilize technology in their instruction in ways that improve student learning (p. 25).
- School leaders will work with others to develop and implement a long-term strategic plan for technology use in the school. The plan, including a code of ethics, will allow for ongoing changes in technology and adapt itself to continual changes in the school program (p. 38).
- Schools will make technology integral to curriculum, instruction, and assessment, accommodating different learning styles and helping teachers to individualize the learning process (p. 38).
- High schools will equip individual classrooms with the technology necessary to prepare students for life in the 21st century (p. 39).
- Budget allocations will be adequate to maintain current technology and to provide for ever-changing technology needs, including sufficient funds to permit access to all students and to use technology to deliver student services (p. 40).
- Technology will be a key part of both initial and continuing teacher education to provide teachers with the knowledge and skills they need to integrate technology into the curriculum and to adapt it to instructional strategies. To achieve these ends, school districts will hire teachers who can use technology to obtain information and who can incorporate technology into teaching and learning (p. 41).
- Every high school will designate a technology resource person to provide technical assistance and to consult with the staff to assist them in finding the people, information, and materials that they need to make best use of technology (p. 42).

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Technology and Curriculum Integration

Inherent in the *Breaking Ranks* recommendations is a recognition that high schools can enrich and expand virtually every activity, operation, and course in the curriculum by using computers and other technologies. Also integral to NASSP's vision of technology utilization in the high school is the proposition that technology not be seen as an "add-on" to the program, but that it be **integrated** into existing courses and programs in ways that meet the individual needs of students. As noted by Eib and Mehlinger (1998) in *The High School Magazine*, integrating technology into education cannot be accomplished merely by a course on computer literacy or by building a computer lab. In fact, what these practices accomplish is "technology segregation"—restricting access to a few teachers and limiting students to a fixed amount of time. Eib and Mehlinger define technology integration as a "process whereby computers and other technologies are used routinely across the grade levels and subject areas as students and teachers perform their work. In this process, education technology is no longer the object of study, it is the means for conducting inquiry. In short, technology is a tool to support the tasks of teaching and learning" (p. 12).

Breaking Ranks also recognizes that successful technology integration does not automatically happen when computers are installed in every classroom. Instead, teachers must incorporate technology into the broad range of their instructional strategies:

> In planning a curriculum unit, the teacher should consider how to strengthen the lesson at each point of the way by employing technology . . . . Teachers ought to identify databases for students to use and inform students when electronic spreadsheets will make it easier for them to organize the material they are studying. In the same way, an appropriate CD-ROM used at the proper moment can inject immediacy into what might otherwise be just another dull lesson. Virtual reality can make a lesson particularly memorable. And, dialing into the Internet may allow a student to reach sources whose firsthand knowledge of a situation can provide original source material (p. 25).

With technology integration, the "sage on the stage" model of teaching is replaced by the "guide on the side" approach, and the role expectation for the teacher changes from being the "source of all answers" to being the "source for learning to ask the right questions" (Academy for Educational Development, 1998).

While technology can be an important tool in the educational process, its role must be kept in perspective. As noted in the technology philosophy statement of the Plano (Tex.) Independent School District: "We believe technology is a tool. It is not an education itself, and it does not and should not take the place of a well-trained professional teacher." The Plano school district also makes clear what it perceives should be the relationship between technology and the curriculum:

> The overriding factor of technology integration is to meet the identified needs of the curriculum. In other words, the instructional program needs to drive the technology implementation. At no time should the technology program restrict what the instructional program needs to accomplish.

Figure 1 provides examples from Rockford (Mich.) High School of how technology can be integrated into specific curricula areas in the high school. Figure 2 describes how technology is integrated into the instruction for students who receive special education services in the Plano (Tex.) Independent School District.

Figure 1

HIGH SCHOOL INTEGRATION INTO ALL CONTENT AREAS

Language Arts	Mathematics	Social Studies	Science
Word processing, spell check, thesaurus, and grammar checking software used in writing process. Database and telecommunications for research. Outline/brainstorm software for writing. Multimedia projects with graphics, text, and sound. Creation of timelines of events. Desktop publishing of newspaper and yearbook on computer. Enhance photographs. Video productions in Television Production class.	Spreadsheets to solve problems. Graphing programs to discover concepts visually. Reinforce basic with computer software. Programming. Probability simulations. Special "word processors" with math symbols. Statistics software.	Atlas/map making. Telecommunications to use online resources. Multimedia projects with graphics, text, and sound. Databases on compact disk. Simulations.	Database and telecommunications for research. Multimedia projects with graphics, text, and sound. Computer probes for measurement/analysis. Optical technologies for research and analysis. Computer interface with lab instruments. Gravity, projectile motion, and other simulation. Download and analyze data from weather satellite. Troubleshooting to solve problems. Nationwide collaboration via telecommunications.
Arts	**Music**	**Physical Education**	**Business Education**
Computer drawing with geometrical shapes or freehand. Design compositions. Critique art work. Scanning images and enhancing on computer. Animation. Enhance photography. Create multimedia portfolios. Database and telecommunications for research.	Database and telecommunications for research. Compact disks on musical classics with analysis and history of writing. Create music. MIDI interface to control music synthesizer. Develop music library. Software to help plan marching band formations/transitions. Digitize/analyze voices.	Body fat analysis for physical fitness. Database for tracking of sports statistics. Computer interfaces to measure pulse in training. Automated timers. Database and telecommunications for research.	Computerized record keeping and accounting. Advanced word processing/publishing. Advanced database and spreadsheet applications. Payroll, inventory management, and other business simulations. Optical technologies for research and simulations.
Foreign Language	**Special Education**	**Technology Education**	**Media Centers**
Foreign language word processors for writing. Vocabulary review via computer. Introduction to languages via digitized voice. Compact disks with digitized speech. Telecommunications for research.	Computer software for remediation. Use technology as tool to accomplish required objectives.	Principles of technology. Robotics. Computer Aided Drafting/Computer Aided Machining (CAD/CAM). Computerized diagnostic devices. Career exploration software. Monitoring and feedback devices. Multimedia reports with graphics, text, and sound.	Computerized card catalog. Multiple databases on compact/video disk. Telecommunications for research. Multiple computer stations for teacher/student use. Multimedia work stations.

Figure 2

Technology Integration in Special Education Services

Plano (Texas) Independent School District

Technology Plan 1997–2000

Technology enables students with learning disabilities access to the curriculum by:

- Providing talking word processors and word prediction programs for proofreading and editing
- Providing software for instruction and reinforcement of the curriculum at an instructional level different than that of peers (IEP driven)
- Providing independent learning activities such as extended practice, tutorials, simulations, etc., that are critical to mastery of instructional objectives
- Providing specialized software intended to increase study skills/organizational abilities
- Providing step-by-step development of computer skills that are often at a slower or different rate than that of non-disabled peers
- Providing laptops or other dedicated devices for those students whose disability impedes the successful completion of writing assignments, research papers, and/or note-taking tasks
- Providing the opportunity to synthesize and analyze new information via a non-judgmental tool

Technology enables students with visual impairments access to the curriculum by:

- Providing screen enlargers for visual access
- Providing screen readers to enable the students to "read" information on the screen for access to most general education software applications
- Providing an Internet web browser (pwWebSpeak) specifically for individual with visual impairments.

Technology enables students with auditory impairments access to the curriculum by:

- Providing software with visual instructions in lieu of auditory instructions
- Providing assistive listening devices so students can participate in classroom instruction, follow-up activities, labs, and performance-based assessments.

Technology Education

Both *Breaking Ranks* and the *Report to the President on the Use of Technology to Strengthen K–12 Education in the United States* (President's Committee of Advisors on Science and Technology, 1997) distinguish between instruction about technology (i.e. technology as a subject matter) and the use of technology to teach skills, ideas, or concepts that may have no relationship to technology (i.e. technology integration). While both reports stress the importance of technology integration, they also both acknowledge the importance of technology education. In fact, *Breaking Ranks* recommends that in addition to integrating technology into existing courses and programs in ways that will meet the individual needs of students, high schools create one or more courses with technology as the subject matter. The goal of such a course would not be to turn students into programmers or webpage designers, or to teach the inner mechanics of computers, but "to serve as a forum in which students can explore the best writings and ideas about technology itself" (NASSP, 1996, p. 39).

An excellent example of a technology curriculum for the high school is that developed by the Farmington (Mich.) Public Schools. The curriculum description is as follows:

> Technology is an integrating discipline which focuses on the systematic application and integration of knowledge and skills, whereby students create appropriate design solutions to solve real-world problems utilizing a variety of materials, tools, and processes. The content of technology is primarily application-based and includes a study of technological evolution, resources, systems, utilization, and analysis of the impact on society, culture, and the environment. Students will also acquire knowledge and skill in the use of a wide range of technologies for communicating and managing information, creative expression, problem solving, research, design, product development, and evaluation. Learning with, and about, technology prepares learners to be confident, capable, and responsible citizens in a technologically complex society.

The technology education content standards and benchmarks at the high school level are presented in Table 2.

Table 2

Technology Content Standards and Benchmarks for the High School Farmington (Mich.) Public Schools

Standard 1: Using and Transferring Technology

All students will use and transfer technological knowledge and skills for life roles (family member, citizen, worker, consumer, lifelong learner).

Benchmarks

Family Member

- Evaluate technological impact on society.
- Identify an emerging technology and forecast the impact of that technology on the family.

Consumer

- Participate in cooperative research and development projects that study consumer satisfaction of comparable products and services.

Citizen

- Identify a social, civic, or economic issue and propose a technological solution.

Worker

- Evaluate present and future job markets in technology-related fields.

Life-Long Learner

- Demonstrate the proper care of technological systems and components.

Standard 2: Using Information Technologies

All students will use technologies to input, retrieve, organize, manipulate, evaluate, and communicate information.

Benchmarks

Communication

- Use technologies to demonstrate skills and a systematic solution to a problem(s) (voice, data, video, graphics, etc.).

Retrieve/Manipulate/Communicate

- Given a scenario, develop multiple options and present the solutions using a variety of technologies.
- Retrieve, communicate, organize, evaluate, and manipulate information using a technological system (voice, data, video, graphics, etc.).

Evaluate

- Evaluate information received through technologies.

Standard 3: Applying Appropriate Technologies

All students will apply appropriate technologies to critical thinking, creative expression, and decision-making skills.

Benchmarks

Decision Making

- Apply technological procedures to overcome obstacles when implementing a solution to a problem.

Creative Expression

- Prepare/present ideas using a combination of technologies aimed at reaching a diverse audience (voice, data, video, graphics, etc.).

Decision Making/Critical Thinking

- Evaluate decisions using technology.
- Use technologies to organize thoughts in a logical process (voice, data, video, graphics, etc.).

Standard 4: Employing a Systematic Approach

All students will employ a systematic approach to technological solutions by using resources and processes to create, maintain, and improve products, systems, and environments.

Benchmarks

Systems

- Design and construct technological systems that exhibit continuous improvement.

Graphic Technological Solutions

- Create working drawings from sketches to meet appropriate industrial standards.

Measurement

- Use measurements of dimension and capacity as criteria to produce and evaluate technological solutions to problems.
- Transfer measurements within appropriate tolerances for the purposes of producing and evaluating technological solutions to problems.

Processes

- Use industrial tools, materials, equipment, and processes to design and produce products addressing given technological problems.

Safety

- Investigate, analyze, and assess potential safety hazards, establish guidelines for safe behavior, and adhere to common safety practices while around or participating in the technological solutions to a problem.

Systematic Approach

- Apply a systematic approach to design solutions to technological problems using investigations, analysis and idea development, proposals, planning, making a prototype of the prototype, and self assessment.

Technological Products and Systems

- Adapt solutions to the needs and values of individuals, groups, society, and environment when designing, redesigning problem solutions and creating a quality end product to meet the need.

Resources

- Analyze resources and processes to choose the best combination to create a technological solution to a problem.

Standard 5: Applying Standards

All students will apply ethical and legal standards in planning, using, and evaluating technology.

Benchmarks

Planning and Evaluating

- Analyze and interpret the impact of differing ethical and legal standards in this age of global competitiveness.
- Explain the associated rights and responsibilities of acquiring for legal documents (e. g., patents, copyrights).

Planning and Using

- Establish an action plan to solve a technology-related problem(s) and assess the plan applying ethical and legal principals.

Using and Evaluating

- Analyze current and emerging issues (e. g., ethical, social, environmental, legal, political, privacy) related to technology.
- Identify and evaluate solutions for solving the ethical problems associated with using tools, equipment, materials, and processes in a technical problem.

Using

- Understand and practice the concept of lifelong learning about technology within an ethical, legal context.
- Analyze the extent to which organizational purposes and actions are compatible with personal standards in the effective and appropriate use of technology.

Standard 6: Evaluating and Forecasting

All students will evaluate the societal and environmental impacts of technology and forecast alternative uses and possible consequences to make informed civic, social, and economic decisions.

Benchmarks

Economic

- Evaluate current uses of technology on one's personal career and occupational goals.
- Analyze and forecast the effects of technology on one's personal career and occupational goals.

Civic/Social

- Evaluate the direct and indirect effect and impact of technological developments on national and international issues.
- Identify and explain how environmental factors contribute to the development of technology and their impact on society.
- Assess the historical development of technology of tools, equipment, and products in relationship to current societal and environmental needs.

Social

- Forecast the impact of technology on individuals in our future society based on present needs.

Civic/Social/Economic

- Propose guidelines for appropriate and effective use of technology in our society as a whole or in a specific sector of society.
- Formulate and support a position about the roles of the government and private sector in creating and influencing policy concerning the use of technology.
- Propose, research, and justify the introduction of new technologies.

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Table 3

National Educational Technology Standards for Students: Foundation Standards and Performance Indicators for Grades 9–12

Technology Foundation Standards for Students

1. *Basic operations and concepts*
- Students demonstrate a sound understanding of the nature and operation of technology systems.
- Students are proficient in the use of technology.

2. *Social, ethical, and human issues*
- Students understand the ethical, cultural, and societal issues related to technology.
- Students practice responsible use of technology systems, information, and software.
- Students develop positive attitudes toward technology uses that support lifelong learning, collaboration, personal pursuits, and productivity.

3. *Technology productivity tools*
- Students use technology tools to enhance learning, increase productivity, and promote creativity.
- Students use productivity tools to collaborate in constructing technology-enhanced models, preparing publications, and producing other creative works.

4. *Technology communications tools*
- Students use telecommunications to collaborate, publish, and interact with peers, experts, and other audiences.
- Students use a variety of media and formats to communicate information and ideas effectively to multiple audiences.

5. *Technology research tools*
- Students use technology to locate, evaluate, and collect information from a variety of sources.
- Students use technology tools to process data and report results.
- Students evaluate and select new information resources and technological innovations based on the appropriateness to specific tasks.

6. *Technology problem-solving and decision-making tools*
- Students use technology resources for solving problems and making informed decisions.
- Students employ technology in the development of strategies for solving problems in the real world.

Performance Indicators

(Numbers in parentheses refer to the standard category to which the performance is linked)

Prior to completion of grade 12, students will

1. Identify capabilities and limitations of contemporary and emerging technology resources and assess the potential of these systems and services to address personal, lifelong learning, and workplace needs. (2)
2. Make informed choices among technology systems, resources, and services. (1, 2)
3. Analyze advantages and disadvantages of widespread use and reliance on technology in the workplace and in society as a whole. (2)
4. Demonstrate and advocate legal and ethical behaviors among peers, family, and community regarding the use of technology and information. (2)
5. Use technology tools and resources for managing and communicating personal/professional information (e.g. finances, schedules, addresses, purchases, correspondence). (3, 4)
6. Evaluate technology-based options, including distance and distributed education, for lifelong learning. (5)
7. Routinely and efficiently use online information resources to meet needs for collaboration, research, publications, communications, and productivity. (4, 5, 6)
8. Select and apply technology tools for research, information analysis, problem-solving, decision-making in content learning. (4, 5)
9. Investigate and apply expert systems, intelligent agents, and simulations in real-world situations. (3, 5, 6)
10. Collaborate with peers, experts, and others to contribute to a content-related knowledge base by using technology to compile, synthesize, produce, and disseminate information, models, and other creative works. (4, 5, 6)

Technology Performance Standards and Competencies for Students

Offering specific courses in technology does not imply that technology education takes place only in the context of these courses. It is incumbent on all educators to create technology-enriched learning environments that provide opportunities for students to use various technologies as part of the instructional process. The International Society for Technology in Education (ISTE), with the support of NASSP and other professional associations, published educational technology performance standards and accompanying Profiles for Technology Literate Students at grades 2, 5, 8, and 12. Educators may use these standards and profiles as guides in developing technology-based activities. ISTE's website (www.iste.org) offers a number of examples and scenarios that reflect not only the National Educational Technology Standards (NETS) and profiles, but the curriculum content standards from organizations such

as the National Council of Teachers of Mathematics and the National Council of Social Studies.

Table 3 provides the Technology Foundations Standards for All Students as well as the performance indicators for grades 9–12.

In addition to, indeed prior to, the development of the ISTE Standards, a number of schools and school districts developed their own standards and competencies for students. Table 4 presents the technology competencies stressed at the high school level in the Plano Independent School District.

Table 4

Technology Competencies for High School Students

Plano (Texas) Independent School District

- Students can create macros and set preferences in software programs to personalize use.
- Students can use advanced features of the Internet as well as information and communication software.
- Students can search for information in on-line catalogs and government sources.
- Students can reference and critique information found through on-line resources.
- Students use technology as a tool to support their achievement across the curriculum.
- Students evaluate information drawn from technology resources for its reliability and validity.
- Students use technology resources to address life skill issues.
- Students turn to technology to acquire new skills and find solutions to problems.
- Students analyze and describe how the presentation of information in different formats affects peoples' perception of the information.
- Students work effectively in teams using technology tools and resources.
- Students can design creative, effective messages for information dissemination, persuasion, education, and entertainment.
- Students demonstrate an understanding of the advantages and limitations of various multimedia.
- Students discover and describe applications for technology tools.
- Students demonstrate an understanding of legal and ethical issues related to technology laws.

Challenges to Technology Integration in the High School

High schools face many challenges as they undertake technology integration throughout the curriculum. Not surprisingly, at the core of most of these is the issue of resources. As noted by the President's Committee of Advisors on Science and Technology (1997), "most of the other challenges would be far less formidable if cost were not an issue" (p. 57). Cost *is* an issue, not only in terms of the cost of the initial investment and ongoing maintenance, but also the costs associated with remodeling facilities, laying the infrastructure to connect classrooms and schools to central offices, providing the necessary technical support, providing teachers with the time and training they need to develop their technological skills, and replacing both software and hardware as required by student growth and obsolescence.

Resources

Technology integration requires a substantial investment of school district resources. During the 1995–96 school year, public elementary and secondary schools in the United States spent as much as $4 billion on computing and networking hardware, infrastructure enhancements, software, technical support, and technology-related professional development. However, despite the magnitude of this investment, cost projections regarding what would be required to introduce and effectively use technology in the schools vary from a low of $6 billion to a high of $28 billion per year, depending of the levels of technology usage (President's Committee, 1997).

The President's Committee of Advisors on Science and Technology (1997) recommends that five percent of all educational spending be earmarked annually for technology-related expenditures. The high costs associated with technology integration underscore the impor-

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tance of planning for purchasing and upgrading, technical support, and professional development. Principals must be prepared to answer questions related to what kind of equipment to buy and how much must be budgeted for maintenance, technical support, and professional development. And as will be discussed later, principals must also be prepared to participate in efforts to secure the resources necessary to support technology integration.

Teacher Time and Training for Technology Integration

No matter how much money the district spends on equipment and software, if teachers are not adequately trained, much of this money could be going to waste. According to a number of experts, "professional development is the biggest bottleneck in the implementation of new technology" (Zehr, 1997, p. 25). Unfortunately, while the need to provide teachers the time and training necessary to develop technology-related instructional skills is great, many districts have insufficient resources available to meet this need. Experts generally agree that if the school's technological equipment is to be used effectively, at least 30 percent of the technology budget should be spent on professional development (Zehr, 1997). However, in most school districts less than half that amount is actually spent. Training is often shortened because "administrators and policy makers tend to think they're getting more for their money if it goes for something they can touch, and they can't touch training" (Zehr, 1997, p. 24).

Developing the competencies necessary to integrate technology into their classrooms requires that teachers make more of a time commitment than simply attending district provided training. It requires a major revamping of everything from lesson plans to the physical configuration of the classroom. The Plano Independent School District Technology Plan puts it this way:

> The integration of technology into the curriculum requires changes of significant magnitude in educational philosophy, classroom management, and curriculum goals. For the technology to be used optimally, teachers must be comfortable with a constructivist or project-based problem solving approach to learning. They must be willing to tolerate and support students' progressing independently and at widely varying paces. Often we are asking teachers to integrate dramatically new philosophies of education, classroom management techniques, and new ideas about interdisciplinary and individualized education into their daily practice.

Zehr (1997) contends that professional development is the biggest bottleneck in the implementation of technology because teachers are so busy. High school teachers spend an average of 52 hours a week on their teaching duties (U. S. Department of Education, 1997). Given their already demanding schedule, most teachers find it difficult to free up time to develop the skills necessary to integrate technology into their classrooms successfully.

The President's Committee of Advisors on Science and Technology (1997) reports that it will take the average teacher three to six years to fully integrate technology into his or her teaching activities. Even then, the on-going changes in technology make it likely that the learning curve will never completely level off. The committee concluded that unless additional time is made available to teachers to develop technology-related teaching skills, existing demands of the job will continue to be an obstacle to the effective utilization of educational technology.

While there is no definitive listing of technology skills or competencies teachers need, the list developed by the Rockford Public Schools and presented in Table 5 illustrates the magnitude of the challenge facing teachers.

Table 5

Technology Competencies for All Educators in the Rockford Public School System by the Year 2000

Essential Skills for Computer Operation, Setup, Maintenance, and Troubleshooting:

1. Start up and shut down computer system and peripheral
2. Identify and use icons, windows, and menus
3. Start an application and create a document
4. Name, save retrieve, revise a document
5. Use printing options
6. Insert and eject floppy disk and CD-ROM
7. Initialize, name/rename floppy disk and hard disk
8. Copy document from hard disk to floppy disk and vice versa
9. Create and name/rename folders
10. Save, open, place document inside folders
11. Open and work with more than one application at a time
12. Make more memory available
13. Exchange disks and files among Macintosh, MS-DOS/Windows
14. Set up computer system and connect peripheral devices
15. Protect and care for floppy disks and CD-ROMs
16. Make backup copies of key applications and documents
17. Use self-help resources to diagnose and correct common hardware/printing problems
18. Install an application.

Word Processing/Desktop Publishing Skills:

1. Enter and edit text copy and move a block of text
2. Change text format and style, set margins, line spacing, tabs, columns
3. Check spelling, grammar, word usage
4. Create a header and footer
5. Insert date, time, page number
6. Add columns to a document
7. Insert clip art into a document
8. Insert images created in a drawing or painting document
9. Create a newsletter, parent letter, etc.

Spreadsheet and Graphing Skills:

1. Interpret and communicate information in an existing spreadsheet
2. Enter data in an existing spreadsheet
3. Create a spreadsheet with rows, columns, headings
4. Create/copy formulas and functions to perform calculations
5. Create a graph from spreadsheet data
6. Insert a spreadsheet into a word processing document.

Database Skills:

1. Use information from an existing database
2. Sort a database by specific fields, add and delete record
3. Create a database with multiple fields and records
4. Create custom layouts including columnar reports
5. Insert database fields into word processing documents

Networking Skills:

1. Use a filesaver (connect/log on, retrieve a program or document, save a document to a specified location)
2. Share files with others on a network

Telecommunication Skills:

1. Connect to the Internet or an on-line service
2. Use e-mail (compose, send, retrieve, read, respond)
3. Access and use resources on Internet and World Wide Web
4. Connect a computer to a modem and telephone line for dial-in access
5. Upload a text file and send as electronic mail
6. Use specialized e-mail list relevant to professional information needs
7. Create and use group addresses for electronic mail
8. Effectively use distance learning and desktop video conferencing where available.

Multimedia Skills:

1. Use a multimedia program (i.e. Hyperstudio) to create a presentation
2. Integrate CD-ROMs, laser discs, and video recording into a presentation
3. Integrate graphics and the Internet into a multimedia presentation
4. Use a large screen display screen to present a multimedia product
5. Develop an assessment for student-generated multimedia products
6. Create a linear and nonlinear presentation
7. Input sound into a multimedia presentation
8. Create simple animation.

Curriculum Skills:

1. Use Rockford Computer Goals for Technology to identify what students should know and be able to do
2. Access resources for planning instruction available via telecommunications (i.e., experts, lesson plans, authentic data, curriculum materials).

Teaching and Learning Environment:

1. Develop performance tasks that require students to locate and analyze information as well as draw conclusions and use a variety of media to communicate results clearly
2. Use computers and other technologies to appropriately collect information on student learning and communication information on student learning
3. Select and create learning experiences that are appropriate for curriculum integration.

Social, Legal, and Ethical Issues:

1. Establish classroom policies and procedures that ensure compliance with district guidelines concerning copyright law, fair use guidelines, security, and child protection
2. Ensure equal access to technology for all students

(Rockford Public Schools Long Range Technology Plan, 1995-2000)

Technical Support

Getting teachers and administrators involved with technology is only half the battle, and one that can be lost if they are not provided with adequate support when equipment fails or they are unable to understand how to use specific software. For this reason, most experts agree that at least in the foreseeable future, schools that are attempting wide scale technology integration need to have on-site technical assistance. At least five kinds of technical assistance are needed:

1. Help in planning for technology uses and acquisitions
2. Training in how to use new hardware and software
3. Demonstrations and advice on how to incorporate technology into instruction
4. On-demand help when software or hardware problems arise
5. Low-level maintenance on the system. (U. S. Department of Education, 1998, p. 3).

Many districts have relied on technically competent teachers or media specialists to provide the necessary technical assistance, but with mixed results. In most instances, teachers attempting to integrate technology in their classrooms want technical help immediately, but find it difficult to interrupt another teacher's work for technical assistance. If teachers have to wait hours, days, or weeks to get their problems resolved, many may abandon their efforts to integrate technology into their classrooms (U. S. Department of Education, 1998).

Technical support personnel include the technology coordinator, technicians who repair and maintain the equipment, and other specialists who assist the faculty and staff (Bailey, 1997). While the ideal would be to have technical experts on staff, districts face not only the challenge of funding such positions, but finding qualified people to fill them. According to Cheryl Williams, director of the National School Board Association's Institute for the Transfer of Technology to Education, technical specialists are getting harder and harder to find (Trotter, 1997). And as in other arenas, larger and more affluent districts are in a better position to hire and support the needed technical staff.

The Role of the Principal in Technology

The principal is a key player in meeting the above challenges. The principal also has two other important responsibilities in technology integration: creating a vision and planning. The role of the principal in specific aspects of each of these areas is discussed briefly here.

Funding

Principals play important roles in educating the community about the technology needs of the schools and in helping the district secure the resources needed to support technology integration. This may involve:

- Working to gain increased public tax support from the state or local level
- Writing or supporting others in writing proposals for competitive grant funds from the state or federal government
- Seeking support from local or national private foundations, corporations, businesses, or community-based organizations.

The Arizona Technology in Education Alliance has developed a set of competencies and a self-assessment checklist for school administrators (for additional information e-mail Webb@ASU.edu or Yohe@mccd.edu). Among these is that the administrator should be able to identify funding sources and costs involved in technology implementation.

Professional Development

The principal is also responsible for helping design a program of professional development that "matches each teacher's abilities and

Figure 3
Teaching with Technology Instrument

Instructions. The purpose of these questions is to examine the current status of your beliefs, understanding, and use of technology in your classroom. Please read each statement and indicate whether you possess that skill by placing a check mark in either the yes or no box to the left.

Yes	No		
❑	❑	1.	Use a word processor to enter text, edit, change the format of a document, save and retrieve documents, check spelling, print documents, and use graphics tools.
❑	❑	2.	Use desktop publishing software to import text, format text and layout, and import graphics by producing a class newsletter.
❑	❑	3.	Demonstrate how word processing enhances the writing process.
❑	❑	4.	Compose and send e-mail to support classroom projects.
❑	❑	5.	Understand the social, legal, and ethical issues related to telecommunication use.
❑	❑	6.	Use writing/communication technology in the discipline/subject for learning.
❑	❑	7.	Understand how writing/communication technology can be used to meet the learning styles of students.
❑	❑	8.	Plan writing/communication activities for computer labs and/or classrooms with one or multiple computer resources.
❑	❑	9.	Demonstrate a knowledge of installation of writing and telecommunication hardware/software and appropriate troubleshooting techniques.
❑	❑	10.	Explore how higher order thinking skills and problem solving can be enhanced by writing/communication technology.
❑	❑	11.	Apply understanding of physical settings, organizational and classroom management strategies that support active student involvement, inquiry, and collaboration.
❑	❑	12.	Apply understanding of the goals of the North Carolina Computer Skills Curriculum as related to writing and communication.
❑	❑	13.	For the title of a document, I can vary the typeface and size (e.g., I can use 18 point Times rather than 10 point Helvetica).
❑	❑	14.	Explain how to insert a forced page break into a document.
❑	❑	15.	Use a spreadsheet by accessing an existing spreadsheet and creating a new spreadsheet to manage and interpret information.
❑	❑	16.	Create a bar graph on the computer that is linked to a spreadsheet.
❑	❑	17.	Enter a function in a spreadsheet cell.
❑	❑	18.	Use a database by sorting an existing database and creating a new database to manage and interpret information.
❑	❑	19.	Use telecommunications by accessing bulletin boards, on-line services, and the Internet.
❑	❑	20.	Access resources for planning instruction available through telecommunications (e.g., experts, lesson plans, authentic data, and curriculum materials).
❑	❑	21.	Understand differences between public domain, freeware, shareware, and commercial sources of software.
❑	❑	22.	Understand the role of media in effective communication.
❑	❑	23.	Understand social, legal, and ethical issues related to information access and management.
❑	❑	24.	Demonstrate the use of information access and management in the discipline/subject for learning and as a medium for communication.
❑	❑	25.	Understand the characteristics, strengths, and weaknesses of media communication tools and techniques.
❑	❑	26.	Demonstrate effective and appropriate use of computers and other technologies to communicate information in a variety of formats on student learning to colleagues, parents, and others.
❑	❑	27.	Understand how information access and management can be used to meet the various learning styles of students.
❑	❑	28.	Plan information access/management activities for computer labs and classrooms with one or multiple computer resources.
❑	❑	29.	Demonstrate a knowledge of installation of hardware/software and appropriate troubleshooting techniques as related to information access and management.
❑	❑	30.	Explore how information access/management technology can enhance higher order thinking skills and problem solving.
❑	❑	31.	Explain what WWW and Veronica mean within the telecommunications context.
❑	❑	32.	Demonstrate or explain to another person how to access an e-mail account.
❑	❑	33.	Understand how to set up and manage a telecommunications project between schools in different geographical areas.
❑	❑	34.	Effectively use distance learning, on-line conferences relevant to professional information needs, desktop teleconferencing, and tele-teaching technologies.
❑	❑	35.	Demonstrate development of performance tasks that require students to locate and analyze information as well as draw conclusions and use a variety of media to communicate results clearly.
❑	❑	36.	Apply understanding of the goals of the North Carolina Computer Skills Curriculum as related to information access and management.
❑	❑	37.	Demonstrate a knowledge of installation of hardware/software and troubleshooting techniques (i.e., CD-ROMs, laserdisc players, LCD panels, television monitors, video equipment, scanners, digital cameras, and teleconferencing equipment).
❑	❑	38.	Understand differences between public domain, freeware, shareware, and commercial sources of software and review copyright laws to ensure compliance with copyright law, fair-use guidelines, security, and child protection.
❑	❑	39.	Understand social, legal, and ethical issues related to multimedia production.
❑	❑	40.	Use and understand the differences between linear multimedia presentation and a nonlinear multimedia presentation. Understand such terms as media, multimedia, hypermedia, and clip media.
❑	❑	41.	Demonstrate multimedia use in the discipline/subject for learning and as a medium for communication.
❑	❑	42.	Understand how multimedia production can be used to meet the various learning styles of students.
❑	❑	43.	Plan multimedia activities for computer labs and/or classrooms with one or multiple computer resources.
❑	❑	44.	Plan a lesson incorporating appropriate technology that includes use of productivity software, on-line resources, or both.
❑	❑	45.	Explore how multimedia production can enhance higher order thinking skills and problem solving.
❑	❑	46.	Apply understanding of the goals of the North Carolina Computer Skills Curriculum as related to multimedia production.

From "The Teaching with Technology Instrument," by Nancy E. Atkins and Ellen S. Vasu. *Learning & Leading with Technology*, Vol. 25, #8, May 1998.
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interests, is continuous, and is linked to the ongoing activities of the classroom and the vision for the school as a whole" (Eib and Mehlinger, 1998, p. 13). The Teaching with Technology Instrument (TTI) developed by Atkins and Vasu (1998) and presented in Figure 3, may help principals assess how much their teachers know about technology and its integration into the classroom. The TTI's 46 questions are grouped into three areas:

- Writing and communication
- Information access and management
- Construction and productivity through multimedia.

Knowing how much the teachers understand and use technology is the principal's first step in planning effective staff development (Atkins and Vasu, 1998).

In the Plano Independent School District, all staff members are required to receive and are compensated for 30 hours of professional development each year, much of which is technology-based. (In 1997–98, the district, which enrolls 43,300 students, spent approximately $1,540,000 on professional development.) The staff development component detailed in the district technology plan explains that as new technologies are implemented, staff members are required to attend training sessions or demonstrate competency before the technology is introduced into their classroom. In addition, staff development plans are required as a component of each new implementation of software or hardware. Each staff development plan must be submitted with the request for software or hardware and must be approved by the appropriate technology, curriculum, and professional development staff.

Technical Support

No matter much how much training they receive, most teachers will need technical support for hardware and software. Principals must work to ensure adequate technical support for their faculty, both from technical support personnel and from faculty peers. Principals should build teams of faculty and staff who can share their expertise and work together to solve their problems (Eib and Mehlinger, 1998).

The following questions can help the principal plan the technical support for the school:

- Who and what is necessary to allow technology integration to proceed smoothly?
- Why are plug-and-play performance and hotline help crucial to effective technology integration programs?
- Are maintenance and repair important parts of technology integration programs? Why? (Bailey, 1997, p. 58)

The Vision

Perhaps the principal's most important charge in promoting technology integration is to help create a vision for the role of technology in the school and a plan to make the dream a reality. The principal should not take sole responsibility for providing the vision, but should involve faculty, staff, students, and parents in a collaborative process to create the vision of what technology integration should accomplish in the school (Eib and Mehlinger, 1998). A clearly articulated vision provides everyone with a picture of the future that will motivate them to move in the right direction and coordinate their efforts.

School Technology Plan

The school district must have a technology plan. The vision created through the collaborative process, no matter how modest or grandiose, will never be realized without careful planning. According to the Farmington Board of Education Policy (No. 6301) the technology plan should include:

1. A process for involving staff, students, and the community
2. Coordination with varied curriculum areas

3. Projection of equipment and software needs, and costs for the curriculum application(s) being proposed
4. Staff training
5. Evaluation of the hardware and software relative to the curriculum design and instruction
6. Annual revisions to the plan.

Regardless of whether or not the district has a plan, principals cannot rely on the district to plan and provide technology for their school; they must be active in the planning process. In whatever ways possible, principals should be involved in the preparation of the district plan and ensure that accurate data from the school is included in all district planning. It also means that principals must provide leadership in developing a technology plan for their schools that will ensure the most effective use of technology and meet the needs of the students. The technology plan should be part of the overall school improvement plan.

The first step in developing a school technology plan is appointing a planning team made up of both educators and community members. Rosanne Winter (1998) principal of Oakton High School in Vienna, Virginia, one of Fairfax County's two technology prototype schools, recommends that the principal appoint a planning team of no more than 12 members representing a variety of content areas, who among them possess the following attributes related to knowledge, ability, and power:

- Ability to envision how technology can help teachers impart content area knowledge to students and how students can interact with the content through technology
- Ability to envision the future and a passion for making the future a reality
- Knowledge of state or local technology competency expectations for teachers and students
- Knowledge of networking, software, and hardware
- Knowledge of the planning process and team building
- Ability to engage others in the process, winning them over when no mandate will make it happen
- Power to manipulate resources; ability to carve out precious time and secure scarce funds, get the attention of area or district personnel, and set priorities that others will respect.

Once the planning team has been appointed and organized, Winter suggests they answer the following questions (numbers 2, 5, and 8 are not from Winter) which provide the basis for the development of the technology plan:

1. What are our goals and objectives?
2. What defines and comprises a technology-enriched learning environment?
3. How will we measure progress toward our objective?
4. How will we help students progress toward the goals?
5. How will we help faculty progress toward the goals?
6. Who will be responsible for getting these work plans into action?
7. When must we get this done?
8. What resources are available and what are needed to get this done?
9. Where will we get the resources to get this done?
10. How are we doing?

Assessment

The last question requires that the school regularly assess what has been accomplished, what remains to be done, the extent to which the objectives of the technology plan have been met, and the effectiveness of various technology initiatives in improving educational outcomes. This assessment can be internal or external, formal or informal. According to Dede (1998) four major student outcomes can be assessed to determine the effectiveness of technology-based teaching models:

1. Learner motivation
2. Mastery of advanced concepts
3. Students' ability to use problem-solving processes similar to those of experts
4. Scores on standardized tests.

Additional criteria that can be used to assess whether technology integration is occurring in your school are provided by Eib and Mehlinger (1998, p. 13):

- Do students and teachers have adequate access to computers and other technologies whenever they need them?
- Is educational technology frequently and regularly used by students and teachers to conduct work routinely associated with the grade level or subject area?
- Has the school system specified a range of student competencies in the use of technology for various grade levels? Are these competencies part of the curriculum? Do teachers take advantage of these student competencies as they plan their courses and lessons?
- Have classroom practices changed as a result of the introduction of technology?

Conclusion

The growing importance and impact of technology on every aspect of the educational enterprise, from the classroom to the board room, mandates that the principal assume leadership in integrating and utilizing technology. The fast rate at which the technology is changing makes the task not only intimidating, but an ongoing challenge. Principals are called upon both to model technology and to work with teachers to transform the teaching and learning process by teaching with technology. This requires that the principal have clear vision of and commitment to the power and potential of technology integration.

In the end, though, the principal, teachers, students, and parents should remember the quote from the Plano school district: "Technology cannot take the place of a well-prepared teacher." Technology is a tool for improving instruction and facilitating learning. And like any tool, it is only as good as the hand that holds it.

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nassp

National Association of Secondary School Principals
1904 Association Drive, Reston, Virginia 20191-1537
(703) 860-0200 • (800) 253-7746 • Fax (703) 476-5432

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